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BANK STABILITY ALGORITHM FOR NUMERICAL MODELING OF CHANNEL WIDTH ADJUSTMENT

by

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Background

In a contract modification the PI and research assistant undertook two additional tasks related to the development of improved bank stability algorithms for use in modeling river width adjustment. These tasks were not specified in the original contract, but were added later in order to take advantage of later developments and strengthen the final product. Specifically, the additional tasks involved:

1. Work at Colorado State University during August 1994 with Dr Chester Watson and Mr John Burgi;
2. Visits to selected US Army Corps of Engineers District Offices during August 1994.

The work at CSU concerned liaison between the researchers performing this project and researchers at CSU working on development of bank stability models for the Demonstration Erosion Control Project on the US Army Engineer, Waterways Experiment Station. The visits to District Offices were designed to allow researchers to discuss bank stability and modeling with practising engineers in order that the researchers could ensure that the model that they were producing was useful and relevant to the needs of river engineers.

Logistics

The PI and research assistant visited the USA for approximately 3 weeks in August 1994 in order to perform the tasks specified under the Contract Modification. The bulk of the time was spent at Colorado State University, but trips were also made to:

Buffalo, New York

Mobile, Alabama

Huntington, West Virginia

Results of Additional Tasks

Work at Colorado State University

Work at Colorado State University centred on liaison between researchers concerned with bank stability in two separate WES studies. Dr Watson and Mr Burgi briefed the PI and Research Assistant on bank erosion processes and mechanisms in the DEC watersheds. They went on to detail the problems generated by bank instability and outlined how engineers responded to those problems when designing mitigation measures. They explained how their understanding of the geomorphological processes, geotechnical mechanisms and engineering impacts of bank instability has formed the basis for a computer program developed to asses the extent of bank instability under existing conditions and to predict the sensitivity of the channel to bank destabilization through head-cutting. The program is named "BURBANK". Watson and Burgi outlined the approach to analysis of bank stability that was included in BURBANK, which was based on the Osman-Thorne bank stability analysis. The PI and Research Assistant spent sometime detailing the capabilities and limitations of the Osman-Thorne method and introducing the improved Darby-Thorne stability analysis. The CSU team explained their approach to dealing with the limited data available to practising engineers. The PI and Research Assistant were able to draw valuable lessons from this applicable to ensuring that the data needs of the Darby-Thorne model are realistic. The PI and Research Assistant detailed their approach to dealing with the spatial and probabilistic dimensions of bank failure. They explained that variability in soil properties and local variations in bank geometry, drainage state and local scour mean that their is a random element to the failure of a bank in a particular river reach. Intense discussion followed, at the end of which both the CSU and Nottingham teams felt better able to account for the probabilistic elements in their respective models. This was, probably, the most fruitful area of discussion.

Visits to District Offices

Location: **Buffalo District, Buffalo, NY**
Date: 5th August, 1994
Interviewer: Colin Thorne
Interviewees: James Boyle, Construction Division, Buffalo District COE
Raoul Yalamanchili, Chief, Hydraulics Design Division, Buffalo District COE

A frank and useful exchange of ideas and information took place. The COE staff briefed the PI on the types of problem encountered in their daily work and the range of options currently employed in dealing with these problems. Discussions included both technical and practical aspects of channel design, operations and management.

The PI came away with a much fuller appreciation of engineering practice and was able to factor this into the product of this study.

Location: **Mobile District COE HQ, Mobile, AL**
Date: Wednesday 24th August, 1994
Interviewer: Stephen Darby
Interviewees: Paul Bradley, Operations Division, Mobile District COE
Ray Gustin, Engineering Division, Mobile District COE
Carvel Deese, Program Management, Mobile District COE

Paul Bradley is primarily responsible for managing the teams of inspectors who conduct annual inspections of the flood control channel projects, to ensure O&M requirements are satisfied. Ray Gustin is more involved in the engineering aspects of failed or at-risk projects. Carvel Deese administers agreements between sponsors and the COE for new projects. Each individual had clear and valuable insights into channel stability problems associated with bank erosion and/or failure. They explained how bank problems fit into the wider aspects of channel design, operation and maintenance. O & M personnel stressed the role of local sponsors responsible for channel maintenance and outlined how poor or inadequate maintenance often triggers bank instability. It was clear from these discussions

that bank erosion and potential instability continues to be a major headache for practising engineers and that improved methods of detecting and, ideally, predicting instability would be of real value. It would also be advantageous to be able to demonstrate the dangers of bank instability to river managers and local sponsors in order to communicate to them the absolute requirement for proper care and maintenance of the banks and riparian zones along flood control channels.

Location:	**Hocking River Conservancy District HQ, Athens, OH**
Date:	Thursday 25th August, 1994
Interviewer:	Stephen Darby
Interviewees:	Ken Halstead, Engineering Division, Huntington District COE
	Bill Randolph, Operations Division, Huntington District COE

Steve Darby met with Ken Halstead and Bill Randolph at the Hocking River Flood Control Project at Athens, Ohio. The project consists of a 24,000' flood control channel constructed in 1969-1971. The project is designed to provide flood protection against a 60 year event (approx) for the city of Athens. The project was initiated in response to major destructive flooding of the city of Athens in 1964. Pre-construction channel widths of about 70' compare to a constructed channel width of 210'. The project shortened the Hocking River through Athens by a total of 1400'. Spoil from channel excavations was used to construct flood embankments to provide additional conveyance. The primary maintenance activity involves periodic (every 2 years) dredging of sediments deposited in the over-widened constructed channel. Other activities include management of vegetation (mainly by mowing) on the banks of the flood channel, and general maintenance of structures associated with the channel.

The morning of the visit was spent walking the length of the project in the company of Ken Halstead and an employee of the HCD. Following the field trip, SED interviewed Ken Halstead and Bill Randolph about aspects of their jobs, O&M problems and issues in the Athens project, as well as in the wider context of the Huntington COE District.

The site inspection allowed first-hand visualisation of the nature and extent of bank problems encountered by practising engineers responsible for the operation and maintenance of a typical Corps flood control project. Input form the local sponsor allowed another valuable perspective to be introduced. The insights and understanding communicated by the field personnel aided the Research Assistant in appreciating aspects of bank stability not normally encountered by mathematical modelers and theoreticians.

Outcome of Contract Modification

Both the BURBANK and Darby-Thorne models are better because of discussions that took place in Fort Collins. The products delivered at the end of both studies have been strengthened by the information and technology transfers that resulted from the additional task authorised under modification P00001.

The field discussions and interviews at Corps District Offices were invaluable in ensuring that the products are appropriate to the problems encountered in Corps Projects and are consistent with the needs of Corps personnel.